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Material Selection Procedure

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Abstract

The material selection procedure is one of the most important processes that we found during inventing or designing or making of any new product or modifying old product with some new attachments or mechanisms. This procedure considers several steps like finding material groups, looking for criteria that we need in our mechanism design, general properties that consider several factors like cost of the material, availability of the material, manufacturing considerations and many more. Main goal for material selection procedure is to minimize the cost of the product without negotiation with performance level of the product. In 1997, George E. Dieter describes basic and functional method of material selection in his book named "Overview of material selection process", ASM Handbook volume 20 material selection and design. In 1999, AshbyMichael F. found new procedure for the material selection which is known as "Ashby Procedure for material selection by bubble graph or Ashby chart".

Keywords: *Material selection procedure, Ashby chart, Bubble diagram for material selection, Materials for product development, CES software for material selection.*

INTRODUCTION

Material selection process is the most crucial stage of the product design. As we know the material selection is the crux in engineering design and development process, so we should follow the best and proper method for selecting material. Before 1999, Ashby gives his Ashby chart to find best material in the millions of different materials scientists and engineers are using trial and error method which costs more. Because at that time, they don't have any kind for software support. This is typical material selection procedure for all time shown in figure 1.

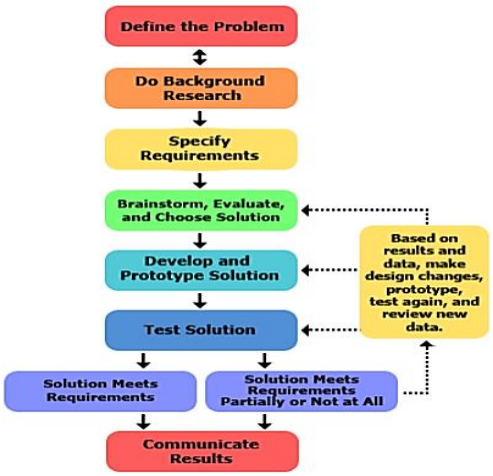

Fig1:*Material selection procedure*

Selecting one material over millions of materials is not easy job when clock is ticking for design procedure. Conventional method or manual material selection process is very time taken and not that much of effective method in practice.By manually there is high possibility that we miss some important material if we have not that much of experience. In material selection procedure we need a tool or method that can minimize our efforts and time taken by the process. These two basic requirements can have fulfilled by Ashby method/Ashby graph.

Material selection is a process which is performed to select the fine materials which may have the potential to perform well both in industrially and commercially. Today selection of materials is an important part of commercial designs due to the fact the competition within the market is heavy.

Failures arising from bad material selection are not uncommon in many industries. In an application that demands a high tensile power, a fabric with better tensile strength has to be selected. If the product is for use outdoors, it may be necessary to consider the effect of ultraviolet light. If a proper material selection is not done, the product life tends to be highly unpredictable. Therefore, the material selection process is quite important for the long-term success of engineering applications.

Facts to Consider in the Material Selection Procedure

In the field of mechanical engineering, the selection of material is a tedious task because there are number of factors that have to be carefully evaluated before making the final decision. The main requirement may be the strength of a particular application, but depending on the working environment and behaviour, several other factors may have to be considered.

In the selection of materials, a systematic approach is necessary to pick the best substances for a specific application. If a proper approach is accompanied, first it is required to carefully define the application necessities in terms of mechanical, thermal, environmental, electric, and chemical homes. Then the selections are narrowed down through the technique of removal. Manufacturing strategies also have a major importance in choosing the best fabric. Fabric assets data sheets by no means should be used for the last selection of materials. The actual overall performance of a selected cloth under unique conditions may additionally range from what is expected.

Material Selection Ensures the Integrity at Design

The integrity of a design can be ensured only after a systematic material selection technique. Otherwise, the result it is highly susceptible for failures. In the selection process, materials might be assessed for tensile strength and modulus, flexural energy and modulus, impact power, compressive power, fatigue patience, creep, and stress-rest houses depending at the application.This will ensure that the design will have a better probability of succeeding. It will also assure that the design is technically fit to obtain desired properties.

Structural Integrity for Lifetime of the Field

A great design may fail in the actual working environment. It may be subjected to a higher load than ever expected. It may be damaged by a chemical. In these ageing

and transient conditions, only a good design with proper material selection may survive. Therefore the material engineer should have the ability to predict the conditions from clues he may already have about what a certain product may face in its actual working conditions. Then he must carefully select the appropriate materials to suit those possible conditions.

Competitive Advantage and Cost

In extreme applications such as the space shuttle, materials selection plays an invaluable role. A tiny bit of negligence may cause a deadly disaster. This applies not only this type of complex designs, but also to the simple designs, too. Proper selection of materials is always advisable to make sure that the product will perform well in an unpredictable situation.

So there are several areas where selection of material is inevitable, but it is becoming even important in this highly competitive industrial arena.

Design Flexibility

One of significant importance of material selection is the fact that it provides the designer a greater flexibility to his design process. He may design several alternative designs and processes and the best performing material can be evaluated by proper material selection procedures. In the material selection phase, the minimum and maximum properties are examined. The designer can modify the design and/or process for possible improvements or adjustments because he knows the limits of the materials exactly. Also in case of a failure, he has the ability to redesign it easily.

These are the main reasons why material selection is inevitable in engineering design. It is becoming more and more important because of the complexity and diversity of the design process and engineering materials today. Therefore knowing the importance of material selection is may be a forward step for any person who is involved in the engineering field.

Ashby Procedure

Michel Ashby of Cambridge University, gave most useful and optimistic process for material selection. To select material, we need three basic things 1) Material group in which we have number of materials 2) Material selection criteria in which number of properties can be fulfilled 3) Comparison Technique for comparing those all materials with their criteria. In Ashby graph we take two material selection properties and compare those with number of materials on two-dimensional graph with criteria that described.

Ashby Plots

Let us take an example of material selection procedure in which we need to select an aero space material which has some pre-described material properties i.e. mechanical strength, density, thermal properties, rigidity, elongation, cost, availability etc. Here we take two groups which can fulfil the material selection criteria which are plastics and metal-alloy group. We compare these materials on Elongation (% strain) vs Tensile strength (figure 2) and melting point vs fatigue strength at 10^7 cycles (Figure 3) graphs which are shown below.

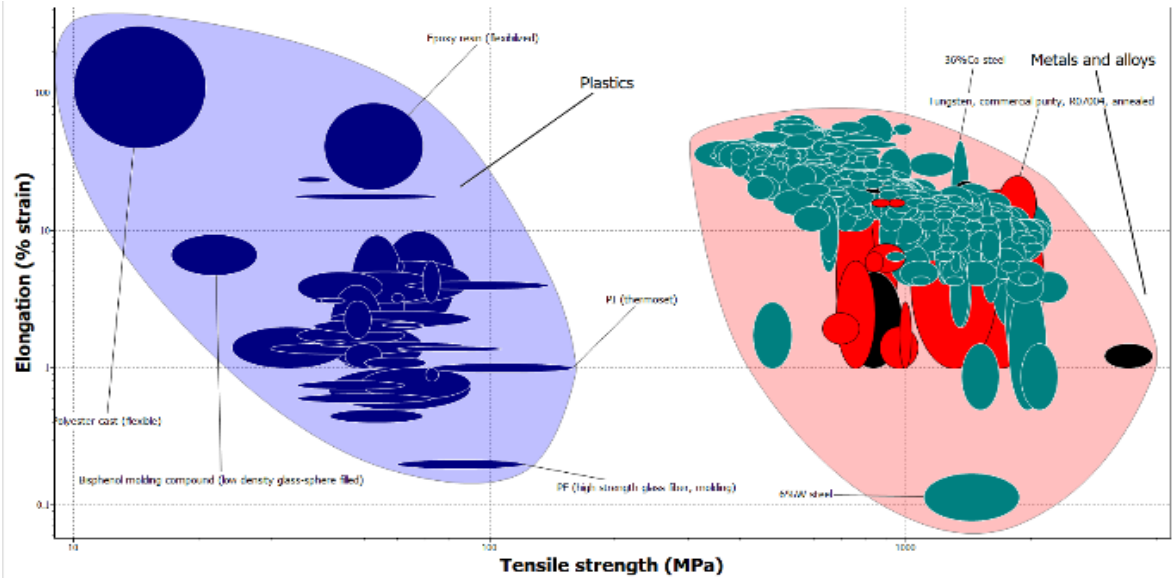

Fig 2: *Graph between Elongation (%Strain) vs fatigue strength*

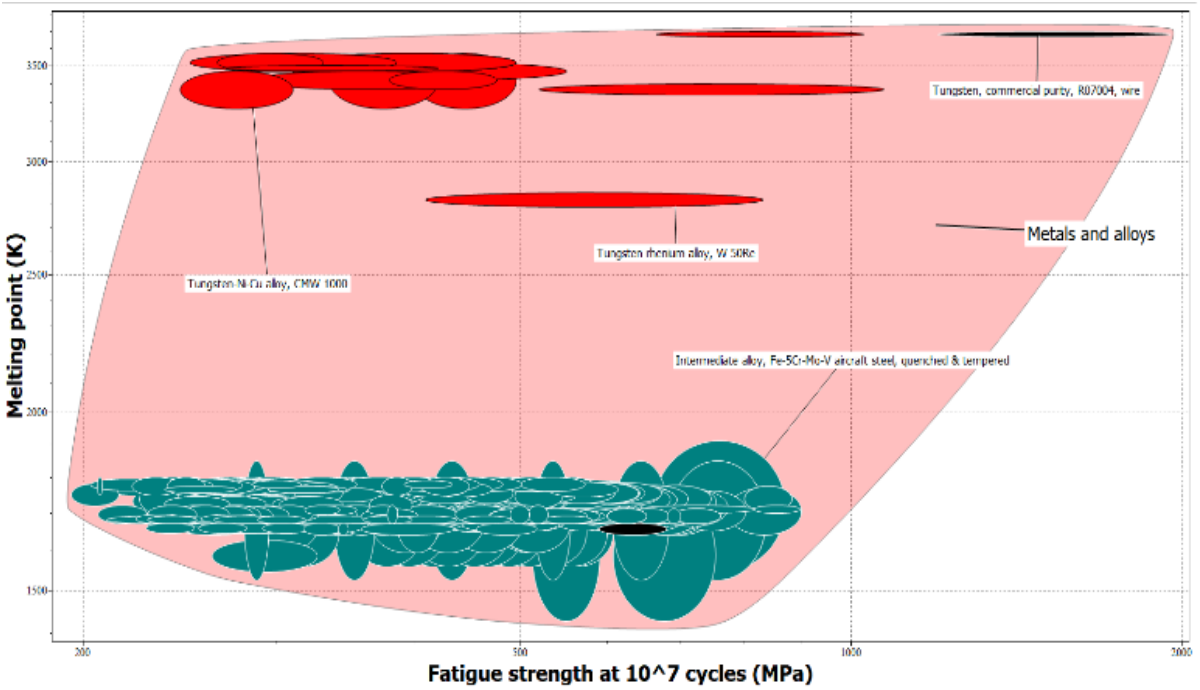

Fig 3: *Graph between melting point vs fatigue strength*

By applying several criteria for materials like elongation should not be exceed 10 % of strain or melting point should not be below 2200 Kelvin, we can find our best suitable material with this process.

CES Software

CES software is one of the best material selection tool that can be found on internet. This software has very big material data with lots of reliability to select material, generate graph and put material property criteria.

CONCLUSION

As we know that the material selection procedure is most important. In earlier stages we uses lots of old methods like trial and error, experience based or typical conventional methods that is not that much

of effective for optimizing cost and material suitability for product. Here is the most suitable method that can make procedure simpler and faster ever. In this process we cannot use pen and paper for Ashby method.Hence, we use software like CES or CES Edupack.

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